

An Essay
on the
Embryonic and Foetal
Circulation

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Circulation

Divided into three different forms

First. Is that of the Viteline Circulation which exists when the Vitellus or the Umbilical Vesicle is the sole source of nutrition for the foetus

Second. The Placental Circulation characterized by the existance of the placenta through the greater part of foetal life

Third. The complete or Adult Circulation and renovation provided for by the lungs. And the nutrition of the blood provided for by the intestinal canal

They Embryonic Circulation begins to form first in the Umbilical Vesicle which is surrounded by the internal membrane of the Blastoderm. The Umbilical Vesicle being at this time the only source of Nourishment, it contains a yellowish white fluid or Yolk upon which the Embryo entirely exists. From the time of fecundation until the placental union takes place through the allantois and has formed a union with the Maternal Complexus of the placental connection. And at the same time and in accordance with the increased growth of the Embryo the Umbilical Vesicle decreases in its area from the immediate flow or draft from it to the embryo. This connection or communication being complete in the formation of a Capillary or Viteline circulation which ^{forms} in a vascular plexus and ramifying through the area.

of the vitelline sack. This *area vasculosa*, is connected to the embryo, by 2 Arteries and two veins, and is accordingly a vascular appendage to the circulatory apparatus of the embryo, spreading out over the surface of the Blastodermis or vitellus, for the purpose of absorbing from it the nutritious material requisite for the growth and vitality of the embryo. And as the hypertrophy of the embryo, so the circulation becomes greater in its extent, and the umbilical-vesicle decreases in its area, according to the increase of the embryo and Allantois. The above named veins, which convey the venous blood, called the Omphalic Mesenteric, enter the Heart at its lower extremity, it being situated at the median line just beneath the Head, and at its upper extrem-

ity it divides into two vessels, and arching over posteriorly, into two separate arches, and each arch forms unions, or anastomoses into itself, and by this means, attains the anterior surface of the vertebral column, passing downwards along the spine, to the posterior extremity, forming the vertebral artery; named so, from their situation, and course, running along the vertebral column, giving off in their course, small lateral branches, to supply the growth, of the body; Also, two larger vessels, the Omphalic Mesenteric vessels or arteries; which pass out as above described into the area vasculosa.

The two vertebral arteries, remaining separate, in the upper part of the body, and as they descend, they form a union, or fuse together, with each other, a little below the Heart, and

below this point, there remains afterwards but one artery, the Abdominal Aorta, passing from above downwards, and giving of small vessels, to the walls, of the intestines, and other organs, for the nutriment of the embryo. . The above description, gives the origin, of the vitatine circulation, but a change, now, begins to take place, and the Allantois, is formed, by a protrusion, from the lower extremity, of the Intestine, carrying with it, two arteries, and two veins; . The arteries, of the Allantois, which are termed the Umbilical, are supplied, by branches of the abdominal aorta. The umbilical veins, at this time, join the mesenteric veins, and empty with them, into the venous extremity of the Heart.

And, as the Umbilical Vessicle, diminishes, the allantois enlarges, and becomes converted

into a vascular Chorion, the arteries, and veins, adhering closely to the chorion, and penetrate into its villa, which forms a sheath to them, all through their ramification. These arteries and veins, each divide, and subdivide, until they become infinitive and hair like, the umbilical arteries anastomosing with each other very freely; The number of these vessels are very large, and more abundant in the center, than else where, they assume a spiral arrangement, and their course is oblique, and continuous with the uterine arteries, and entwine together, from which, the circulation is kept up from the Maternal to the Embryo, and a continual circulation goes on all the time: from the Mother to the embryo.

The villa of the chorion, is penetrated by these infinitive divisions of the arteries, &c.

and veins, both the uterine and fetal side forming cotyledons or tufts, showing that the placenta, is formed of vessels belonging to the Mother, as well as by those appertaining to the child. The Maternal or — utero placental vessels penetrate at all points of its uterine surface, forming in its substance a network of delicate meshes;

While, the Umbilical infinitive vessels, that penetrate into the foetal surface, present the same ramification, and twist around, and embrace the maternal meshes, of the maternal plexus, in all directions. although this connection, is so very intimately entwined, the extremities of the vessels of the maternal side, do not anastomose, or extend their external extremities with those of the Foetus.

The coronary vein encircling the periphery of the placenta, it communicates at short distances with the uterine veins, and receive contributions internally & externally, and some of these spread over the uterine surface of the placenta, and anastomose with the veins that penetrate this body at its center, but some which are less numerous, ramify into the substance of the decidua. two or 3 inches from the circumference of the placenta, and communicate, by their outer extremities with the uterine sinuses. that are situated at about 2 inches from the placenta periphery.

The external unity of the Infinitive veins and arteries as above described, make it evident that the internal tunic of the Mothers vessels, is prolonged on to each-

placental tufts in such a manner, that the maternal blood arriving by the utero placental arteries, passes into a large sack, formed by the internal lamina of these vessels, and the blood is thus divided into different directions by the placental villi which project into them pressing their soft parietes before them, forming sheaths which completely envelopes each trunk and each branch.

And the blood entering into these sacks by the utero placental veins without any extravasation of the vascular system

This fully explains the fact, that the blood of the Foetus or Embryo, cannot have any unity, only through this spongy mass of parietes or tunics, the connection existing between these two orders of vessels,

results from the membranous sheath that envelopes them both. The chorion furnishes the one sheath, and the other by the lamellar prolongations, of the inter utero placental tissues, or as above described by being compressed and united with each other, by the intervention of a common substance, these divisions and subdivisions forming cotyledons of the placenta.

The placenta is composed of two parts which are quite distinct, and yet, formed into one single mass at the end of gestation.

The one, is the Foetal portion, which is the most adherent to the chorion, from which it takes its origin.

The other part, is a greatly thickening of the utero mucus membrane, so as to give admission to tufts.

The Placenta and the Heart of the Embryo
now being connected in their circulation, and
and the placenta being the only source of
nourishment from the maternal blood, the
vessels become very much increased in
their size, because, as the Embryo becomes
larger, it requires more nourishment.

But as above mentioned, there are in the
first place two umbilical veins and arteries,
but soon after this connection has taken
place, the one vein atrophies and disappears,
and the one remaining, becomes enlarged
according to the requirement of blood
to be conveyed for the support and
vitality of the Embryo, after this change
there are but two arteries and one
vein enclosed in the umbilical cord,

As before stated, the venous blood enters into the heart, at its inferior extremities, by the umbilical vein, and when passed through the heart, the vertebral arteries receive it, which pass up and form two separate arches, and return posteriorly to each other along the vertebral column, and anastomose into themselves, and form four other unions into each arch above the heart. These extend up along the neck forming the right and left subclavians, vertebral carotids and supplying the brain, insculating through the circle of Willis, and also give off the superior intercostals, the left arch forms the Aorta, and remains permanent during life. and one of the sections from the left arch forms the —

Ductus Arteriosus which remains only during Foetal life. The right aortic arch disappears in a short time. and each of the arteries give off branches to supply the Head. Body. & extremities, at this time the Heart has twisted upon itself, forming a simple twisted tube, and the blood passing through it in a single continuous stream, and corresponding changes take place with the Abdominal Aorta, which runs undivided along the median line. giving off its lateral branches, which supply the intestines, and parietes of the body; and two of these accompany the Allantois, and become the umbilical arteries, these two increase so much in size, that they soon appear as divisions of the Aortic trunks; and the original continuation of this trunk. ap-

pears only as a small branch; when the lower extremities begin to be developed, they are supplied by two branches given off from the umbilical arteries. At this time the pelvis and posterior extremities are but slightly developed, the arteries that supply them, extend, according to the growth of the extremities, and continue to give off branches in their course; The External & Internal Iliac^s, and Femorals, each bifurcating, and giving off their proper branches and the permanent arteries become developed in the inferior extremities. The Hypogastric Arteries arising from the internal Iliac^s become atrophied in adult life, into solid rounded cords passing up to the umbilicus. The Arteria Sacra Media is the terminal continuation of the Aorta running along the sacrum supply-

ing branches to the rectum and anterior
sacral nerves.

The Veins of the body consist of two long venous trunks or (Vertebral Veins) and run along the spinal column parallel with the vertebral arteries and receive the intercostal veins emptying into the heart by two trunks of equal size (Canals of Cuvier) . . . When the inferior extremities become developed their two veins returning from below join the vertebral veins near the posterior portion of the body. and crossing them afterward unite with each other. and form a new vein entering into the lower extremity of the heart

The two branches by means of which the veins of the lower extremities thus unite become the common iliac veins and

the single trunk resulting from their union, becomes the vena cava inferior, which bifurcates and forms the two iliac.

As the Superior Extremities increase in their size and distention, the intercostal vein becomes larger in their caliber, and finally extend and form the right and left Subclavian Veins; and at the same time the upper vertebral veins become the right and left juglar vein. And a branch arises from the left vertebral and crosses and fuses into the right vertebral vein which gives a communication for the blood to pass from the left side of the head down into the right descending vertebral vein into the right heart and only a portion of blood flows down the left side.

This oblique vein increases in size

and finally conveys all the blood from the left superior extremities and left side of the head and the increase in size and capacity is such as to give room for all the blood to pass through it into the right side of the heart and it becomes the Vena Cava Inferior.

And the inferior part of the superior vertebral below the union of the oblique remains only as a branch for the connection of the intercostal veins and the base of the right vertebral vein receives the blood from the oblique and the whole superior extremities and becomes the lower portion of the vena cava superior receiving the blood from the right and left subclavian and juglars. The original inferior vertebral veins receive the right intercostal

vein and form the lumbar intercostals.

And that of the right side becomes the vena azagor. major, and those of the left side at the lower part of the abdomen send out transverse branches and unite with the vena cara inferior, and a communicating vessel arises. and forms the vena azagor. minor, and the upper left vertebral vein becomes the superior intercostal vein, receiving the 6 or 7. intercostal veins of the left side and by this change the venous blood all flows into the Heart from the Superior extremities through the descending vena cara. And the inferior vena cara is formed from the veins of the lower extremities and becomes the ascending vena cara and empties into the right side of the heart, also the left canal

of Curvier has now disappeared and all the venous blood enters the Heart as above described through the Inferior and Superior Vena Cavae.

The Liver being formed upon the Omphalic Mesenteric Vein by a vascular tissue which forms around it a little below the heart in the upper part of the abdomen. and as soon as the organ has attained a considerable size the vein forms into branches or capillary plexus penetrating this tissue which becomes vascular and the vein unites again into trunks and convey the blood through them into the heart by the vena cava. The Omphalic Mesenteric Vein below the Liver becomes the portal vein and above the Liver between it and the heart it receives the name of the Hepatic Vein

by this means the Liver is supplied with blood, through the portal vein coming from the Umbilical Vesicle or placenta, and must necessarily pass first through the Liver into the Vena Cava Inferior. . . When the Allantois forms the connection of the placenta, the umbilical vein from it, joins with the Oesophageic Mesenteric vein in the substance of the Liver, and becomes an agent in forming more capillary plexus; and after this time the umbilical vein from the umbilical vesicle becomes atrophied; And the placenta gains functional importance, and conveys more blood through the umbilical vein from the placenta, through the liver than passes through the portal vein and supplies the left lobe entirely with its own branches. . . And forming a communication

with the portal vein internally, it assists in supplying the right lobe with umbilical blood, thus forming two different sources of supply to the liver, and from a branch which is formed internally of the plexus of the liver, into the ductus venosus which has an immediate continuation through to the hepatic vein

Having explained the Embryonic circulation through the first stage by the venous system to the Heart, or that which forms the heart also the Arteries and some of their changes I must in part recapitulate upon the Heart, to explain more fully the development of Foetal Life, until term with the development of the Heart and the Arteries; ... By the progress of the heart's growth it soon doubles upon itself and

the exit of the arteries are placed more upon a horizontal level. The exit of the veins is a little below and behind that of the Arteries making the heart a twisted tube and the blood passing through it in a single stream, but this single stream is soon divided by a division growing into this twisted tube forming right and left apertures by this longitudinal partition is formed the right and left sides of the heart. . . About this same time the pulmonary branches are given off. from each side of the Arterial trunks near to its origin, and on the same side of this division that has its connection with the right side of the Heart. Very soon after this division of the heart takes place the vessel itself divides at the base of the heart passing up above where the pul-

pulmonary branches are given off and again uniting above and forming a junction, this is the commencement of the Aorta and its right lateral division is the trunk or base of the pulmonary artery giving off its right and left pulmonary branches. This portion of the pulmonary trunk which passes up and unites freely with the aorta is the Ductus Arteriosus which is as large as the pulmonary trunk because it is part of it, and nearly the whole of the blood coming from the right ventricle passes directly onward through the arterial duct and enters the Aorta without going into the lungs.

The lungs gradually become developed and they require more blood for their nutrition and the pulmonary branches and ductus arteriosus increase in proportion

to the pulmonary trunk

The two Auricles of the Heart being divided from the two Ventricles by a horizontal Septa which grows from the internal surface of the cardiac walls. but this septa being incomplete permits of the free passage of the blood from the Auricle to the Ventricles. Also the interauricular septa or that which divides the Auricle is perforated by an oval shaped opening called the foramen of Ovale. allowing of a free passage from the right to the left Auricle and these openings permit of the intermixture of the blood as it passes from the vena cava Inferior and Superior into the Heart they do not enter from the same parts. The vena cava Superior is situated anteriorly directed downward and forward. The vena cava in-

ferior is situated posteriorly and transversely from right to left to the axis of the heart and the blood from this, crossing the direction of that from the vena cava superior, and passing through the foramen ovale into the left auricle, at the same time the blood from the superior vena cava enters into the right Auricle passing downward through it into the right ventricle. The current of blood coming from the vena cava inferior is directed in its course by the Atrachian Valve. it may be said to flow directly into the left Auricle.

The Arteria Innominata together with the left carotid and subclavians are given off from the arch of the aorta before its junction with the Ductus Arteriosus. This arrangement causes

the two Vena Cavae not only to direct the blood into the heart in different directions but also to be distributed in different directions in the body after leaving the ventricles. The blood from the superior extremities passes through the right auricle down into the right ventricle and out of the right ventricle through pulmonary arteries and ductus arteriosus into the abdominal aorta the umbilical arteries the placenta and lower part of the body. The blood of the inferior vena cava enters the right auricle guided by the Eustachian Valve into the left auricle then passes into the left ventricle and from the left ventricle into the arch of the Aorta and is distributed into the superior extremities before it arrives at the arterial

duct and this blood returning from the placenta through the inferior vena cava from the umbilical vein part passing first into the liver and then through the Ductus Venosus. This is the newly oxygenated or maternal blood and become mixed with that blood which is returned from the inferior extremities. and is distributed to the head and superior extremities through the vessels given off from the arch of the aorta before going to the inferior extremities. The above described circulation proves without the least doubt that the placenta serves the double purpose of a respiratory and nutritive organ in receiving the blood from the foetus and returning it again reoxygenated and charged with additional nutritive

material which feeds and gives continual vitality and life to the foetus.

After Birth when inspiration is established in the lungs the sanguiferous fluid flows through the pulmonary arteries into the lungs and there become oxygenated. at the same time the air causing an expansion of the lungs pleura diaphragm and of the whole thoracic cavity and by this change the foetal circulatory organs become changed into that of adult life some vessels atrophy others enlarge and are better developed. The ductus arteriosus soon atrophies and loses its existence also part of the hypogastric arteries & the umbilical vesicle. The descending Aorta unites and forms itself into a vessel devoid of the arteriosus. The Foramen ovale becomes

closed at about the tenth day after birth

The arteriosus degenerates into an impervious cord which serves to connect the left pulmonary artery to the arch of the aorta. The umbilicus or hypogastric arteries between the fundus of the bladder and umbilicus degenerate about the fourth or fifth day after birth and form the anterior true ligament of that viscus.

The umbilical vein becomes obliterated in a few days after birth and forms the round ligament of the liver.

The ductus venosus obliterates after birth into a fibrous cord and may be traced along that fissure. in adult life.

After the above changes have taken place the Adult Circulation commences and with few changes continues for life

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